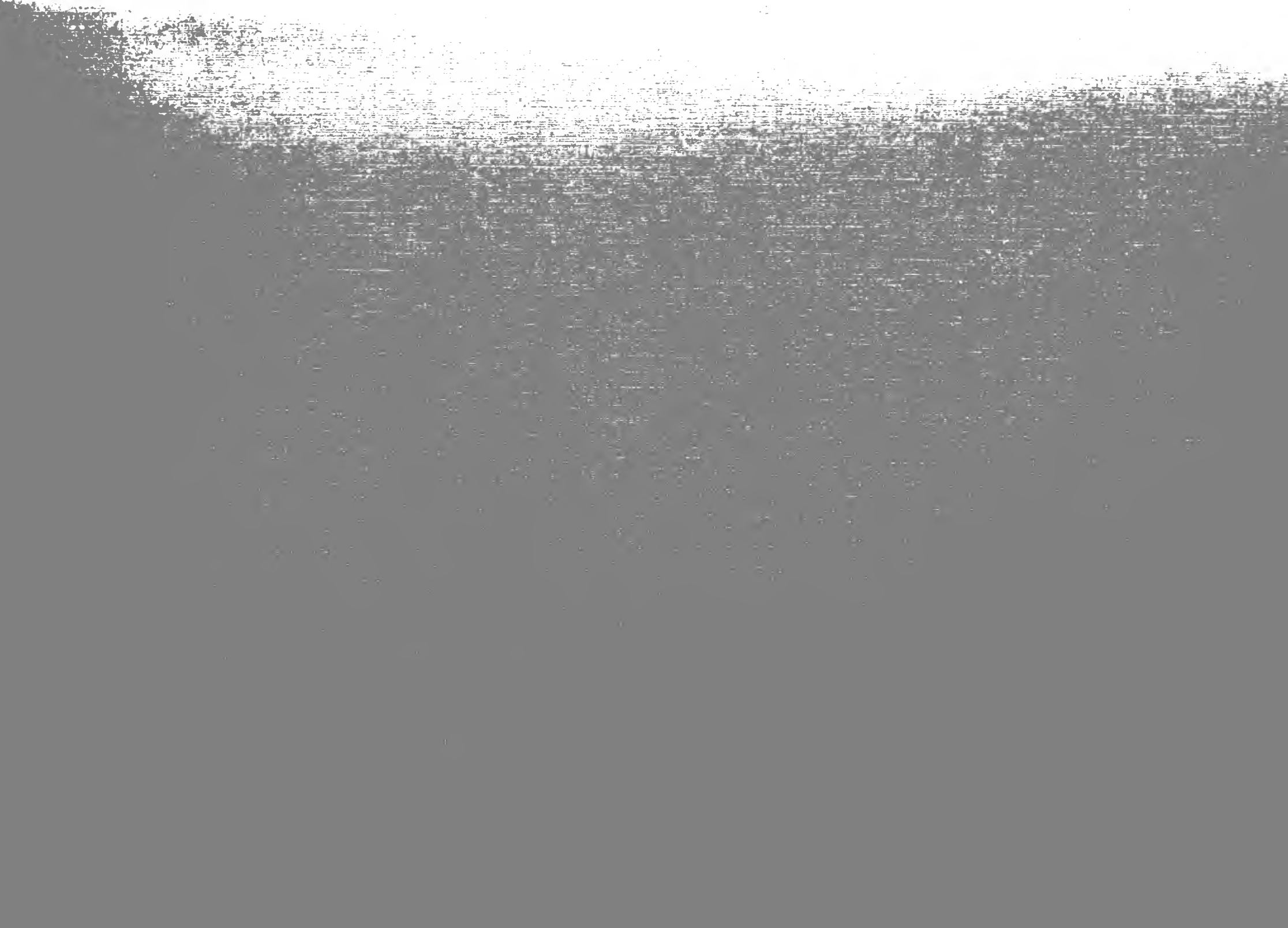

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Bankruptcy, Working Capital and Funds Flow Components

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ABSTRACT

In recent years the theoretical linkages that integrate short-run financial planning components into long-run valuation models have been developed. Simultaneously bankruptcy studies found a few aggregate working capital ratios to be key measures in predicting financial failure. However, these empirical studies on predicting financial failure did not have an underlying theory for selecting specific ratios, and frequently a brute empiricism approach was used to determine the significant explanatory ratios. The result was the selection of ratios that tended to be sample dependent. To overcome this criticism we turned to a cash based funds flow model that measures the interaction of all cash flows within the firm. Inspecting the time series trends of disaggregated working capital funds flow components of failed companies suggested they might improve the ability to classify financially failing enterprises. We substituted five working capital components for the one aggregate net working capital component and tested the classification ability of each set. The empirical analysis utilized MDA and probit programs. The results found the funds flow components with five working capital measures provided superior information for differentiating between failed and nonfailed firms. Additionally, the probit model found dividends, capital investment and receivables funds flow components were significant in distinguishing between failed and nonfailed firms. In summary, cash based funds flow components with decomposed working capital components are a viable alternative for classifying failed and nonfailed firms.

BANKRUPTCY, WORKING CAPITAL AND FUNDS FLOW COMPONENTS

The long-run financial success or failure of a firm is often closely related to the success or failure of its short-run financial performance. Financial theory focuses on long-run financial planning with major emphasis on the decision areas of investments, capital structure and dividend policy, e.g., Brealey and Myers [1981], Brigham [1982], Van Horne [1980] and Weston and Brigham [1981]. With long-run wealth maximization as the normative criterion, valuation models provide the unifying theme for the development of financial theories related to investment, financing and dividend decisions.

In the early stages of the capital asset pricing model (CAPM) the assumption of perfect market conditions resulted in the exclusion of short-run policy and planning decisions from the CAPM. Under these assumed conditions with no transfer costs, the firm has no incentive to hold short-run financial assets or liabilities, Cohn and Pringle [1980]. That is the certainty-equivalent returns or costs in the CAPM are assumed to equal the risk free rate (R_F). The perfect market assumption is incapable of dealing with the investment in marketable securities or receivables, Lewellen, McConnell and Scott [1980], or the use of short-run borrowing. Additionally the assumption of a static, one period, long-run based CAPM is unresponsive to the dynamic, short-run adjustments that are experienced in the management of a firm's working capital position.

The need for integrating short-run investment and financing components into either the CAPM or the present value valuation models has

been recognized by many authors. A variety of techniques have been suggested. For example, Warren and Shelton [1971] and Francis and Rowell [1978] used a simultaneous equation model to integrate working capital components into the total valuation process of the firm. Cohn and Pringle [1980] indicated working capital policies could be employed to keep a firm's shares in a given risk class. They observed the fluid nature of working capital components act as an adjustment mechanism to offset swings in the real asset value of the firm. Knight [1972] and Krouse [1974] recognized the complexity of the short-run financial management and suggested the need to structure hierarchical goals that integrate short, intermediate and long-run objectives in the modeling of the financial decision making process. Smith [1980] advocated the need to integrate working capital policies into the capital investment process of a firm. Gentry [1980] designed a simulation model that integrates working capital components into the capital investment decision process. Recently, Sartoris and Hill [1983] extended the firm valuation model by explicitly including credit policy decisions in the maximization of a firm's net cash flows. In summary, the theoretical literature recognizes that short-run investment and financing decisions make a significant contribution to the value of a firm and should be explicitly included in valuation models.

Empirical studies that use financial ratios to predict bankruptcy highlight the importance of short-run financial management performance in classifying failed and nonfailed firms. A summary of the significant ratios in fourteen failure classification studies is found in Table 1. Under the general heading of short-term liquidity, the

current ratio was found to be significant in classifying failed/nonfailed companies in studies by Tamari [1966], Beaver [1968], Deakin [1972], Elam [1975], Libby [1975], Altman, et al. [1977] and Ohlson [1980]. The quick ratio, another measure of short-term liquidity, was significant in classifying failed firms in studies by Deakin [1972], Edmister [1972] and Elam [1975]. The ratio of cash/current liabilities, as a measure of a firm's cash position, was found to be a significant discriminating variable by Deakin [1972], Edmister [1972], Elam [1975] and Libby [1975]. Table 1 also shows inventory turnover and receivables turnover were significant classification measures in a few studies.

It has been recognized by Foster [1978, p. 477] and others that previous bankruptcy studies have used a brute empiricism approach to choose 20 to 40 variables and, then rely on a stepwise discriminant method to select the variables for the final discriminant analysis. Examples of these studies are Altman [1966; 1971; 1983], Altman and Loris [1976], Altman and McGough [1974], Altman, Haldeman and Narayanan [1977], Beaver [1966; 1968], Blum [1974], Castagna and Matolcsy [1981], Deakin [1972], Diamond [1976], Edmister [1972], Elam [1975], Lev [1971], Libby [1975], Moyer [1977], Sinkey [1975], Taffler [1982], and Taffler and Tisshaw [1977]. The significant ratios selected in these studies were dependent on the data sample used in the empirical analysis. Because there is not an underlying theoretical rationale to justify the selection of specific ratios, the empirical findings cannot be generalized to indicate the most likely predictors of financial distress. To overcome this shortcoming we

turned to a cash based funds flow model developed in 1972 by Helfert [1982] and suggested in the FASB Exposure Draft [1981].

Financial theorists agree that net cash flows are the basis for determining the value of a firm, e.g., Brealey and Myers [1981], Brigham [1982], Van Horne [1983], Weston and Brigham [1981]. The need to use cash flows from operations in predicting failure has been suggested by Largay and Stickney [1980], Mensah [1983], Ohlson [1980], Scott [1981], and Zavgren [1982]. Using the working capital method for calculating a sources and uses statement, Casey and Bartzak [1983] found cash flow from operations did not improve the classification of failed companies. Unlike financial ratios which serve as proxies for measuring cash flows, cash based funds flow components unambiguously measure cash inflows and outflows. This study develops a common set of cash based funds flow components.

Another criticism of earlier bankruptcy studies focused on the shortcomings of multivariate discriminant analysis (MDA). The statistical problems of MDA were identified by McFadden [1973], Eisenbeis [1977], Joy and Tollefson [1975], Santomero and Vinso [1979], and Ohlson [1980]. An alternative to MDA is the use of a conditional probability model. The use of conditional probit analysis avoids the problems related to the use of MDA. With a conditional probability model no assumptions have to be made regarding prior probabilities of bankruptcy and/or the distribution of the predictor variables. The empirical analysis in this study utiltizes MDA and probit programs.

The objectives of this study are to offer cash based funds flow components as an alternative to financial ratios for classifying the financial performance of companies; to test empirically the ability of

funds flow components to distinguish between failed and nonfailed companies with special emphasis on working capital components; to analyze the empirical results and make recommendations for future study.

THE MODEL

Rationale

Net cash flow is composed of cash inflows and outflows. In an accounting context, cash inflows equal cash outflows. The level and speed of each cash inflow and outflow component reflect the operating, investment and financing decisions of management. For a given state of economic conditions, the mix of the components generating cash inflows or outflows is a signal of the resource allocation decisions of management. Measuring the change in the level and speed of each cash inflow and outflow component provides a theoretical rationale to differentiate between financially successful or financially failing firms.

The financial success or failure of a firm is related to the level and speed that net cash flow components move through a firm. The higher the level and/or speed that net cash flow components move through the firm, the smaller the probability of failure. For example, the level of net cash flow from operations rises when either the quantity or price of products sold increase or when the cost of operations for a given level of sales are decreased. There is an increase in the speed that net operating cash flows move through a firm when sales increase more rapidly than investment, i.e., assets turnover is increased. The result reflects increased efficiency in the management of assets.

The development of the preceding framework makes it possible to construct a set of propositions that relate the trend of the cash inflow and outflow components to the probability of failure.

1. The larger the proportion of net cash inflow coming from operations, the smaller the probability of failure. [The larger the difference between cash inflows and outflows from operations, the higher the return on sales and the greater the financial strength of a firm.]

2. The larger the proportion of net cash outflow going to capital investment, the smaller the probability of failure. [The size of the net cash outflow going to capital investment directly reflects the competitive position of the firm, the size of its market share and the expected growth in demand for its products.]

3. The smaller the proportion of net cash inflow coming from outside borrowing, the smaller the probability of failure. [The larger the net cash flow from operations, the lower the need to borrow in order to meet the cash outflows for investment. As net operating flows become smaller, the need to borrow may increase to meet cash flow shortfalls. The higher the flow of funds from borrowing, the greater the financial risk and the higher the probability of failure.]

4. The smaller the proportion of the net cash outflow going to interest and leasing expenditures, the smaller the probability of failure. [The smaller the fixed coverage expenditures in relation to operating earnings, the lower the financial risk and the chances of failure.]

5. The smaller the proportion of net cash outflow going to net working capital, the lower the probability of failure. [Net working capital is considered to be under control when it is increasing at a lower rate than the rate of increase in sales. Net working capital (NWC) equals Δ accounts receivable plus the Δ in inventories plus the Δ in other net working capital items minus the Δ in accounts payable. Working capital components are imperfectly related to sales, but the relative increase in the turnover of receivables or inventories or the relative decrease in the turnover of accounts payable are considered an increase in internal operating efficiency.]

6. The larger the relative proportion of net cash outflow going to dividends, the smaller the probability of failure. [Companies paying a higher proportion of their cash outflows in dividends are signalling not only their financial ability to pay the dividend, but they are satisfying the preferences of their stockholders.]

7. The larger the proportion of inflows that result from an increase in other liabilities (e.g., accrued income taxes) or a decrease in other assets, the lower the probability of failure. [Companies with a trend of increased deferred income taxes and/or decreasing other assets are experiencing investment growth, while companies with declining income taxes and/or increased other assets are experiencing a decline in investment growth.]

Components

The model we have used to identify funds flow measures was developed in 1972 by Erich Helfert [1982]. We selected Helfert's cash based funds flow model to classify bankrupt firms and to measure the contribution of working capital components in the evaluation of financial performance. After extensive use of Helfert's funds flow model, we redesigned it to have eight major components. The eight net funds flow components are operations (NOFF), working capital (NWCFF), financial (NFFF), fixed coverage expenses (FCE), capital expenditures (NIFF), dividends (DIV), other asset and liability flows (NOA&LF) and the change in cash and marketable securities (CC).

The funds flow components contained in the revised model are presented in equation (1).

$$NOFF_t + NWCFF_t + NFFF_t + FCEF_t + NIFF_t + DIV_t + NOA\&LF_t - CC_t = 0 \quad (1)$$

Because the interrelationship among the components is complex, equation (1A) is presented in a sources and uses format of a most likely case. Excepting changes in cash and marketable securities, a source (S) would be a positive number and a use (U) would be negative:

$$\underset{(S)}{+}NOFF_t + \underset{(U)}{-}NWCFF_t + \underset{(S)}{+}NFFF_t + \underset{(U)}{-}FCEF_t + \underset{(U)}{-}NIFF_t + \underset{(U)}{-}DIV_t + \underset{(U)}{-}NOA\&LF_t - \underset{(U)}{+}CC_t = 0 \quad (1A)$$

Because the relative funds flow component is our key measure used to classify failure, a brief discussion of this measure follows.

The algebraic sum of the components in (1A) equals zero, therefore, the contribution of each component in relation to the total

that were deleted from the Compustat Industrial Files due to failure related circumstances during the twelve year period.

We searched leading information sources, F&S Index of Corporate Change [1970-1979], Fisher [1971; 1975], Financial Stock Guide Service [1982], Wall Street Journal Index [1981], to determine why a company was deleted from Compustat. There were 92 companies classified as failed, i.e., 68 involved in bankruptcy and 24 were liquidated. These 92 companies are the failed companies used in this study.

During the third phase of the screening process, the recorded date of failure is compared to Compustat's date of the last reported annual report of the failed company. Although Compustat files do not report the precise date the last annual report was released, they explicitly indicate if bankruptcy was declared before or after Compustat received the annual report. For all of the failed companies selected to be used in the analysis, the Compustat files indicated bankruptcy was declared after they received and recorded the last annual report.

Balance sheet and income statement information for the failed companies are used to determine the funds flow components. Leases were not capitalized as recommended by Altman, et al. [1977], because these data were not available for all of the selected companies during the three years studied. The relative funds flow components were computed for one, two and three years immediately prior to the date of failure for each of the 92 failed companies. Complete financial statement information for one, two and three years before the failure date was available for only 33 of the 92 failed companies. Among the 33 companies, 21 were industrial and 12 were a mixture of other industries.

Matching

Previous bankruptcy studies have matched the sample failed companies with a sample of nonfailed companies that were in the same respective industries and of approximately the same asset size. Generally, the number of matching companies was arbitrarily determined by the authors. Theoretically the best criterion for selecting matching companies would be to match each failed company with the proportionate number of existing nonfailed companies during the period. For example, the average business failure rate between 1970 and 1981 was 38 per 100,000 firms (Altman (1982, p. 32)) which would require 2,631 matching companies for each failed company or 86,842 matching firms for our sample. Compustat Industrial Files have approximately 2,000 companies which makes proportionate matching impossible. In contrast, matching a failed company with one nonfailed company predetermines a marginal failure rate of 50 percent which is less than optimal, but it is not an unrealistic test. Although the results may be slightly biased, we choose to utilize a one-to-one matching sample.

This study matches each of the 33 failed companies with a nonfailed company in the same industry, i.e., selecting matching companies that were similar in asset size and sales for the fiscal year three years before bankruptcy. The matching nonfailed company was required to have the necessary financial information for the respective three years of the failed company. A list of the 33 failed companies and the matching set of 33 nonfailed companies is presented in Tables 2 and 3, respectively.

ANALYSIS

One objective of the analysis is to determine if relative funds flow components can discriminate between failed and nonfailed companies. A second objective is to substitute for net working capital (NWCFF/TNF) its five component parts--receivables (AR/TNF), inventories (INV/TNF), other current assets (OCA/TNF), payables (AP/TNF) and other current liabilities (OCL/TNF)--and determine if the discriminating ability of the model is improved. MDA and probit techniques are used to examine the predictive ability of the funds flow components. Although the components were calculated for one, two and three years before failure, the best statistical results came from the data presenting (1) one year before failure and (2) the mean of each variable for three years before failure. The analysis utilizes these two sets of components and reports the results from the MDA and the probit models.

MDA Results

The mean of each funds flow component is presented in Table 4. A brief review of these data shows there is generally a marked difference between the means of the failed and nonfailed companies. Also the standard deviations are substantially larger for the components of the failed companies. Additionally, a component whose mean was an inflow for the failed companies was frequently an outflow for a nonfailed company, and vice versa.

Figure 1 is a graphic presentation of the mean of each relative funds flow component for the 33 failed and 33 nonfailed companies for the three years preceding bankruptcy. The graphics show the three

year trend of the relative funds flow components for the failed versus the nonfailed companies. Vivid changes in the trend of the flow components of the failed companies are observed in operations, investment, net working capital and fixed coverage expenditures. Figure 2 highlights the trend of the relative working capital components, short-term borrowing component, and change in cash and marketable securities components. The trends of these components that changed most significantly for the failed companies are accounts receivable, accounts payable, inventories, and short term borrowing. Additionally, the graphics highlight the differences in the level of the mean funds flow components for failed and nonfailed firms for the three periods. In Figure 1, these differences are most apparent in the operations, investment, working capital, fixed coverage expenditures and dividend components; in Figure 2, they are found in receivables, payables, inventories and short-term borrowing.

The ability of the funds flow components with either an aggregate or five disaggregated working capital components to discriminate between failed and nonfailed companies is found in Table 5. The tests using data for one year before failure with one working capital component indicate that 82 percent (27/33) of the failed companies were classified correctly and 88 percent (29/33) of the nonfailed companies were identified correctly. When the working capital components are included separately, the classification of the failed companies is slightly lower at 76 percent, but modestly higher for the nonfailed companies, which are all classified correctly. In MDA the percent correctly identified is similar to the R^2 measure in regression

analysis. For the tests using the three year average data, Table 6 shows that with an aggregate working capital component, 79 percent (26/33) of the failed companies and 88 percent (29/33) of the nonfailed companies were identified correctly. THe classification rates are slightly higher when the five working capital components are used.

Probit Results

The probit model discussed in Judge, et al., [1981], or McKelrey and Zavoina [1975] is a conditional probability model that utilizes the coefficients of the independent variables to predict the probability of occurrence of a dichotomous dependent variable. As a nonlinear model, probit provides unique insight vis-a-vis the linearly based MDA model.

The classification results of the probit analysis are presented in Tables 5 and 6. In Table 5, using funds flow components with a single working capital measure for one year before failure, the probit technique correctly identified 79 percent (26/33) of the failed companies and 85 percent (28/33) of the nonfailed companies. When the working capital components are disaggregated, the classification results are slightly higher, as shown in Table 5. Using the mean of each funds flow component for a three year period prior to failure, probit correctly classified 82 percent (27/33) of the failed companies and 73 percent (24/33) of the nonfailed companies. With the five working capital components Table 6 shows the classification results are modestly higher for the nonfailed companies and slightly lower for the failed firms.

In summary, when comparing the five working capital measures to the single aggregated measure with data for one year before failure,

the total classification success ratio is modestly higher with both the MDA and probit model. With the use of mean results for three years before failure, both MDA and probit tests show the disaggregated working capital components give slightly higher total classification performance. On balance, the five working capital components generate classification results that are slightly higher than when using a single working capital component.

Probit Coefficients

In addition to the classification results, the probit model identifies the variables that are significant in classifying failed and nonfailed firms. Probit calculates the weight each coefficient contributes to the overall prediction of failure or nonfailure. The probit coefficients are similar to the coefficients that compose the Z score developed by Altman [1968].

The probit coefficients and the asymptotic T ratios are presented in Tables 7 and 8. For the probit test in Table 7 that use funds flow components one year before failure with a single working capital measure, only the dividend component (DIV/TNF) is significant at the .05 level. When the five working capital components were substituted for the aggregated working capital measure, three of the thirteen components were significant at the 5 percent level. The significant components were investment (NIFF/TNF), dividend (DIV/TNF) and receivables (AR/TNF). The substitution of the working capital components provided insightful information concerning the classification of failed and nonfailed companies that was not previously available in studies by Gentry, Newbold and Whitford [1983].

The test results that used a three year mean for each component are reported in Table 8. When the single working capital component (NWCFF/TNF) was included, only the dividend component (DIV/TNF) was significant at the 5 percent level in classifying the companies. When the five working capital components were substituted for NWCFF/TNF, the flow scale measure (TNF/TA) and dividend (DIV/TNF) were significant at the 5 percent level. None of the working capital components were significant.

The results show the smaller the relative dividend component, the higher the probability of failure, which is supportive of the previously developed proposition 6. A typical failing firm tends to lose its market share and experience a shortfall of funds from operations, thereby causing a reduction in its dividend payments. The decline in relative dividend payments was not a statistically important variable in previous bankruptcy studies that cited ratios. However, this finding may be related to the time period of the study, the use of funds flow components vis-a-vis financial ratios, the probit model versus the MDA model, a combination of these factors or more complex reasons.

The study shows the larger the net investment component, the lower the probability of failure. This finding closely resembles proposition 2 which indicates the larger the size of the net outflow going to capital investment, the higher the anticipated growth in demand for a firm's products.

Finally, the study discovered a receivables effect, i.e., the higher the inflow of funds from accounts receivable, the greater the probability of failure. That is, using information one year before

failure shows receivables were a source of funds for firms that eventually failed. In contrast, the matching nonfailed companies extended more credit than they collected and thereby expanded receivables. However, when averaging the AR/TNF component for three years prior to failure, the receivables effect did not exist. Figure 2 presents a graphic illustration of the behavior of the mean AR/TNF component for three years before failure.

Comparison of Probability Distributions

A comparison of the probabilities of failure determined by each technique for the two sets of statistical data provide unique insight concerning these models. Tables 9 and 10 present the distribution of the probabilities of failure and nonfailure in rows of ten equal size segments. The information in Table 9 is based on models using the one year before failure data and the results are subdivided into one and five working capital components. The distributions of the failed firms are presented in one column under each of classification technique. The distribution of the nonfailed firms are shown in the adjoining column under each classification technique. Table 10 contains similar probability information based on data that are means of the components for three years before failure.

A few key observations emerge from Tables 9 and 10. The classification probabilities of the MDA results are clustered at the extremes for the correctly identified failed and nonfailed companies, e.g., in Exhibit 9 under the one working capital component heading, 19 of the 33 firms classified as failed firms were in the .90 to 1.0 probability

range and 22 of 33 nonfailed firms have a probability of failure between zero and .1. Only a few firms fall in the segments near the .5 probability level. Tables 9 and 10 show the probabilities of classifying failure with the probit model are more widely disbursed across the probability ranges.

The MDA probability results give a strong positive identification to the correctly identified companies, while the probit technique provides a more diffused identification of the correctly classified companies. For the MDA technique there are only a few companies close to the .5 probability of failure level, which indicates only a small chance of the misclassification being in the grey zone. The grey zone contains more companies when the probit model is used.

Likelihood Tests

We completed four separate probit analyses in order to measure the contribution of the funds flow components with specific attention to working capital components in classifying failed and nonfailed companies. From the probit analysis, the change in the log of the likelihood function statistic serves as the basis for measuring the significance of the contribution of working capital funds flow components. The first test uses only the intercept to classify the 66 sample companies. The objective of initially using only the intercept to classify the sample companies is to establish a standard for comparing the change in the likelihood statistic when fund flow components with a single working capital component are added, and when the five working capital fund flow components are substituted for the one working capital measure. The log of the likelihood function statistic for Test 1,

intercept only with data from one year before failure, is -45.748 and is reported in Table 11.

The second test adds eight funds flow components to the probit analysis. In Test 2, we include the NWCFF/TNF component. When the eight ratios for Test 2 are added, the likelihood statistic drops to -28.737 as reported in Table 11. A Chi Square test of the change in the likelihood statistic from -45.748 to -28.737 is significant at the .01 level. This test shows funds flow components make a significant contribution in classifying the 66 companies.

In Test 3, the five working capital components are substituted for NWCFF/TNF. The likelihood statistic for Test 3 was -23.366 and the change in the likelihood statistic from Test 1 to Test 3, -45.748 to -23.366, was significant at the .01 level. A Chi Square test of the change in the likelihood statistic from -28.737 to -23.366 was significant at the .05 level. This test shows the substitution of the five working capital components make a significant contribution in classifying the 66 sample companies, when compared to using only the eight components with an aggregated working capital component.

The log of the likelihood test using the mean of three years of data are shown in the lower part of Table 11. The results from this test are identical to the preceding likelihood tests with one exception. The substitution of the five working capital components did not statistically improve the classification results vis-a-vis using the one aggregate net working capital component.

CONCLUSIONS

Cash based funds flow components are a set of uniform measures that provide common information concerning the cash flow performance of a

firm. These unambiguous measures of cash flow provide significant information in classifying failed and nonfailed companies. This cash based model does not use stepwise probit regression to search through a cross section of financial measures to find the best combination of components, rather it utilizes a standard set of theoretically justified components to discriminate companies on the basis of cash flow performance. We discovered the dividend component (DIV/TNF), the investment component (NIFF/TNF) and the receivables component (AR/TNF) provided significant information for classification purposes. The receivables effect was present in the data one year before failure, but not in the data averaged over the three years before failure. For failed companies, receivables were a large inflow of funds one year before failure. The essence of this discovery is that a specific short-run financial planning component is closely related to an explanation of financial failure.

Previous studies have explained financial failure with long-run financial planning ratios and/or highly aggregated working capital ratios. In this study the aggregated working capital component (NWCFF/TNF) was not significant in classifying companies. However, the decomposition of the working capital component into its five subcomponents resulted in superior information for classifying failed and nonfailed companies.

Cash flow from operations (CFO) is a short-run financial performance measure that is often considered a prime candidate for predicting financial failure. In our study none of the components of CFO--NOFF/TNF + NWCFF/TNF - FCE/TNF--is significant. Casey and Bartczak [1983] have also found similar results.

Future studies should test the model with a hold-out sample. A hold-out sample was not possible in this study because the total sample of 33 companies was too small. Also future studies should use the five component working capital funds flow model to classify financial performance on the basis of size, industry, and competitive position within the industry.

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TABLE 1[10]

AUTHORS AND RATIOS FOR FOURTEEN BANKRUPTCY STUDIES

	Return on Investment													Capital Turnover								Financial Leverage																Short-term Liquidity				Cash Position					Inventory Turnover							Receivable Turnover			Size
	NI/TA	EBIT/TA	NI/S	σ EBIT/TA	σ NI	CF/TA	NI/NW	CF/NW	EBIT/S	Δ NI	Slope NI	Trend Breaks		CA/TA	QA/TA	NWC/TA	S/TA	CF/S	NW/S	S/EA		log EBIT/INT	EBIT/INT	INT/NI	RE/TA	TD/TA	MVCS/BVNW	ID/NW	CL/NW	WC/NW	CF/CL	CF/TD	MVEQ/BVTD	MVEQ/TD	BVEQ/TD		CA/CL	C/TA	CL/TA	QA/CL	Quick Flow	No Credit Interval	C/CL	C/TA	C/S		CA/S	INV/S	Prod/WC	S/WC	NWC/S	CGS/INV	Prod/INV		QA/INV	QA/S	S/Rec	
1966 Tarmari											3														2												X																X		X	
1966 Beaver	X															X										X					X																									
1968 Altman		X														X	X								X								X																						
1968 Beaver	X					X										X										X										X						X													
1972 Deakin	X													X	X	X										X						X				X				X			X	X	X	X									
1972 Edmister																		X											4		X									4			4				4									
1974 Blum							X		X			X	X																				X	X							6			X									5	X		
1975 Elam			X			X	X	X	X						.		X	X								X		X			X	X				X		X	X				X												
1975 Libby	X													X													X									X	X		X				X				X								
1977 Altman, et al.		X		X																		X			X		X									X										X								X
1977 Moyer		X														X									X							X																						
1980 Ohlson	X									X						X										X						8				7																		X
1982 Taffler		9													X											X				X																					X			
1983 Mensah									X											X			X	X	X							X														X								
TOTAL	5	4	1	1	1	2	2	2	1	1	2	1		2	2	6	2	1	1	1		1	1	1	5	6	1	1	1	1	2	7	1	1	1		6	1	1	3	1	1	4	1	2		2	1	1	1	1	1	1		1	2	1	2

1. Value of Production = Sales + finished goods + goods-in-process; ratio not included in Chen and Shimerada [18].
2. Used TL in denominator.
3. Trend of net income, combined with NI/TA for one category of index of risk.
4. Company ratio/industry ratio.
5. Standard deviation, trend breaks and slope of the QA/S ratio.
6. Quick Flow = C + N.Rec. + ms + (S/12) CGS - Deprec. + S&Admin Expense + Interest) 2. A trend break occurs when the performance of a variable declines between year t and t+1.
7. Inverse, i.e., CL/CA.
8. CF = funds provided by operations.
9. TA_{t-1}
10. A footnote number is sometimes substituted for an X.

Table 2

SAMPLE OF FAILED FIRMS COMPUSTAT INDUSTRY CLASSIFICATION AND YEAR OF FAILURE

Company Name	Compustat Industry Classification	Year of Failure*
Westates Petroleum Co.	Crude Petroleum & Natural Gas	1975
Cott Corp.	Bottled-Canned Soft Drinks	1977
American Mfg. Co.	Textile Mill Products	1978
Scottex Corp.	Textile Mill Products	1972
Lynnwear Corp.-CL A	Apparel & Other Finished Products	1979
Nelly Don, Inc.	Apparel & Other Finished Products	1977
Wentworth Mfg. Co.	Apparel & Other Finished Products	1971
Mansfield Tire & Rubber Co.	Lumber & Wood Products	1978
Brody (B.) Seating Co.	Household Furniture	1979
Paterson Parchment Paper Co.	Paperboard Containers	1973
Rowland Inc.	Misc. Chemical Products	1974
APCO Oil Corp.	Petroleum Refining	1976
EDG Inc.	Petroleum Refining	1975
PASCO Inc.	Petroleum Refining	1975
RAI Inc.	Footwear Except Rubber	1971
Sitkin Smelting & Refining	Secondary Smelting-Refining	1977
Gray Mfg. Co. (i)	Misc. Metal work	1974
Gladding Corp.	Radio-TV Trans. Equip.	1976
Computer Instruments Corp.	Electronic Components NEC	1976
Harvard Inds. Inc.	Electronic Components NEC	1970
Waltham Industries Corp.	Electrical Mach. & Equip.	1970
Leader Intl. Industries Co.	Motor Vehicle Parts	1972
Merchants, Inc.	Trucking-Local & Long Dist.	1978
St. Johnsbury Trucking Co.	Trucking-Local & Long Dist.	1974
Kirby Industries Inc.	Water Transportation	1975
Overseas National Airways	Air Transportation	1977
Shulman Transport Enterprises	Transport Service	1977
Reeves Telecom Corp.	Radio-TV Broadcasters	1979
De Jur AMSCO Corp.-CL A	Wholesale-Mach, & Equip.	1976
Arlans Dept. Stores, Inc.	Retail-Dept. Stores	1970
PKL Cos. Inc.-CL A	Service-Advertising Agencies	1971
Plaza Group Inc.	Service-Advertising Agencies	1973
Computer Applications, Inc.	Service-Business Services	1969

*The last year of annual financial statement information reported in Compustat before actual failure of the company. The data is within a maximum of 8 months before failure or 4 months after failure.

Table 3

MATCHING SAMPLE OF NONFAILED FIRMS, COMPUSTAT INDUSTRY CLASSIFICATION AND YEAR OF FAILURE

Company Name*	Compustat Industry Classification	Matching Year
Universal Resources	Crude Petroleum & Natural Gas	1975
MEI Corp.	Bottled Canned Soft Drinks	1977
Gaynor-Stafford Inds.	Textile Mill Products	1978
Compo Inds.	Textile Mill Products	1972
Movie Star Inc-CL A	Apparel & Other Finished Prod.	1979
Decorator Industries Inc.	Apparel & Other Finished Prod.	1977
Raven Industries Inc.	Apparel & Other Finished Prod.	1971
Pope & Talbot Inc.	Lumber & Wood Prod.	1978
Ohio-Sealy Mattress	Household Furniture	1979
Clevepak Corp.	Paperboard Containers	1973
Park Chemical Co.	Misc. Chemcial Products	1974
Total Petroleum of N America	Petroleum Refining	1976
Total Petroleum of N America	Petroleum Refining	1975
Holly Corp.	Petroleum Refining	1975
Barry (R. G.)	Footwear Except Rubber	1971
Refinement Int'l Co.	Secondary Smelting & Refining	1977
Struthers Wells Corp.	Misc. Metal Work	1974
Watkins-Johnson	Radio-TV Trans. Equip.	1976
T-Bar Inc.	Electronic Components NEC	1976
Thomas & Betts Corp.	Electronic Components NEC	1970
Whitaker Cable Corp.	Electrical Mach. & Equip.	1970
Dyneer Corp.	Motor Vehicle Parts-Access.	1972
Banner Industries, Inc.	Trucking-Local & Long Dist.	1978
Rocor International	Trucking-Local & Long Dist.	1974
Tidwater Inc.	Water Transportation	1975
Texas Air Corp.	Air Transportation	1977
WTC Inc.	Transportation Services	1977
Gross Telecasting	Radio-TV Broadcasters	1979
GNC Energy Corp.	Wholesale-Mach. & Equip.	1976
Mercantile Stores Co. Inc.	Retail Dept. Store	1970
Foote Cone & Belding Comm.	Service-Advertising Agencies	1971
Foote Cone & Belding Comm.	Service-Advertising Agencies	1973
Fox-Stanley Photo Products	Service-Business Services	1969

*The nonfailed companies are arranged in matching order with the failed companies in Exhibit 3.

Table 4

MEAN FUNDS FLOW COMPONENTS FOR FAILED AND NONFAILED COMPANIES FOR TWO MDA TESTS

ONE YEAR BEFORE FAILURE

Funds Flow Component	Group 1 Failed		Group 2 Nonfailed	
	Mean	S.D.	Mean	S.D.
TF/TA	.25741	.1409	.22650	.0951
NOFF/TNF	.16335	.5286	.55646	.2474
NWCFF/TNF	.13030	.4531	-.12962	.3444
NOA&LF/TNF	-.04404	.2589	.04776	.1787
NFFF/TNF	.16752	.4905	.14064	.3695
FCE/TNF	-.15299	.1278	-.08043	.0958
NIFF/TNF	-.16349	.2882	-.36766	.2672
DIV/TNF	-.01881	.0502	-.09220	.1033
CC/TNF	-.08182	.2900	-.07496	.2434
AR/TNF	.10035	.3516	-.16937	.2575
INV/TNF	.01357	.4858	-.12646	.2460
OCA/TNF	.01746	.1485	-.02030	.0658
AP/TNF	.17093	.5599	.10151	.3937
OCL/TNF	-.17201	.6808	.08502	.2418

MEAN OF VARIABLE FOR THREE YEARS BEFORE FAILURE

TF/TA	.25569	.1363	.21974	.0764
NOFF/TNF	.28846	.3445	.58885	.2288
NWCFF/TNF	.00723	.2916	-.10282	.1975
NOA&LF/TNF	-.01830	.2026	.02954	.0640
NFFF/TNF	.12042	.3425	.09055	.2113
FCE/TNF	-.12622	.1009	-.07918	.0623
NIFF/TNF	-.22021	.1705	-.36426	.2114
DIV/TNF	-.02228	.0493	-.09392	.1060
CC/TNF	-.02911	.1453	-.06878	.1087
AR/TNF	.01344	.3042	-.15108	.1958
INV/TNF	-.06158	.2113	-.11708	.1674
OCA/TNF	-.00276	.0220	-.01557	.0326
AP/TNF	.14722	.2602	.13959	.2121
OCL/TNF	-.08907	.3891	.04133	.2506

Table 5

CLASSIFICATION MATRICES FOR FAILED AND NONFAILED COMPANIES BASED ON RELATIVE FUNDS FLOW COMPONENTS WITH ONE NET WORKING CAPITAL AND WITH FIVE SEPARATE WORKING CAPITAL COMPONENTS ONE YEAR BEFORE FAILURE USING MDA AND PROBIT

ONE NET WORKING CAPITAL COMPONENT

	Number Correct	Percent Correct	Percent Error	N
MDA				
Failed	27	81.82	18.18	33
Nonfailed	29	87.88	12.12	33
Total	56	84.85	15.15	66
PROBIT (Pr < .5)				
Failed	26	78.79	21.21	33
Nonfailed	28	84.85	15.15	33
Total	54	81.81	18.18	66

FIVE WORKING CAPITAL COMPONENTS

MDA				
Failed	25	75.76	24.24	33
Nonfailed	33	100.00	0.00	33
Total	58	87.88	13.64	66
PROBIT (Pr < .5)				
Failed	26	78.79	21.21	33
Nonfailed	29	87.88	12.12	33
Total	55	83.33	16.67	66

Table 6

CLASSIFICATION MATRICES FOR FAILED AND NONFAILED COMPANIES BASED ON MEANS OF VARIABLES WITH ONE AND FIVE WORKING CAPITAL COMPONENTS FOR THREE YEARS BEFORE FAILURE USING MDA AND PROBIT

ONE WORKING CAPITAL COMPONENT

	Number Correct	Percent Correct	Percent Error	N
MDA				
Failed	26	78.79	21.21	33
Nonfailed	29	87.87	12.12	33
Total	55	83.33	16.67	66
PROBIT (Pr < .5)				
Failed	27	81.82	18.18	33
Nonfailed	24	72.73	27.27	33
Total	51	77.27	22.73	66

FIVE WORKING CAPITAL COMPONENTS

MDA				
Failed	27	81.82	18.18	33
Nonfailed	31	93.94	6.06	33
Total	58	87.88	15.15	66
PROBIT (Pr < .5)				
Failed	26	78.79	21.21	33
Nonfailed	26	78.79	21.21	33
Total	52	78.79	21.21	66

Table 7

PROBIT COEFFICIENTS AND ASYMPTOTIC T RATIOS WITH ONE AND FIVE WORKING CAPITAL COMPONENTS USING DATA ONE YEAR BEFORE FAILURE

	ONE WORKING CAPITAL COMPONENT		FIVE WORKING CAPITAL COMPONENTS	
COMPONENTS	COEFFICIENT	ASYMPTOTIC T RATIO	COEFFICIENT	ASYMPTOTIC T RATIO
CONSTANT	.762	.859	1.567	1.164
NOFF/TNF	-.348	-.364	1.257	.871
NWCFF/TNF	.574	.723	-	-
NOA&LF/TNF	-2.672	-1.677	-1.040	-.514
NFFF/TNF	-.301	-.290	1.580	1.067
FCE/TNF	-.843	-.381	2.713	.887
NIFF/TNF	1.600	1.397	3.678	2.308**
DIV/TNF	9.892	2.521**	13.133	2.652**
TNF/TA	1.493	.648	.129	.044
AR/TNF	-	-	4.339	2.594**
INV/TNF	-	-	1.253	.986
OCA/TNF	-	-	2.490	.672
AP/TNF	-	-	2.086	1.638
OCL/TNF	-	-	.560	.525

**Significant at the .05 level.

Table 8

PROBIT COEFFICIENTS AND ASYMPTOTIC T RATIOS WITH ONE AND FIVE WORKING CAPITAL COMPONENTS USING THE MEAN OF COMPONENT THREE YEARS BEFORE FAILURE

	ONE WORKING CAPITAL COMPONENT		FIVE WORKING CAPITAL COMPONENTS	
COMPONENTS	COEFFICIENT	ASYMPTOTIC T RATIO	COEFFICIENT	ASYMPTOTIC T RATIO
CONSTANT	.792	.813	.073	.063
NOFF/TNF	.163	.091	1.630	.700
NWCFF/TNF	1.299	.623	-	-
NOA&LF/TNF	-4.190	-1.640	-6.094	-1.994
NFFF/TNF	-.038	-.017	-.008	-.003
FCE/TNF	-1.828	-.557	-2.041	-.462
NIFF/TNF	3.155	1.552	4.245	1.691
DIV/TNF	12.126	2.374**	17.691	2.906**
TNF/TA	2.945	1.040	7.362	2.027**
AR/TNF	-	-	3.656	1.037
INV/TNF	-	-	2.115	.819
OCA/TNF	-	-	4.532	.471
AP/TNF	-	-	2.649	.853
OCL/TNF	-	-	-.470	-.166

**Significant at the .05 level.

Table 9

PROBABILITY OF FAILURE FOR FAILED AND NONFAILED COMPANIES DETERMINED BY MDA AND PROBIT USING INFORMATION WITH ONE AND FIVE WORKING CAPITAL COMPONENTS FOR ONE YEAR BEFORE FAILURE

ONE WORKING CAPITAL COMPONENT

Probability of Failure	MDA		Probit	
	F	NF	F	NF
.000 -.1000	3	22	2	9
.1001-.2000	1	4	-	4
.2001-.3000	-	3	1	8
.3001-.4000	-	-	2	3
.4001-.5000	2	1	2	4
.5001-.6000	1	-	4	3
.6001-.7000	2	-	3	-
.7001-.8000	3	1	3	-
.8001-.9000	2	1	4	1
.9001-1.000	19	2	12	1
TOTAL	33	33	33	33

FIVE WORKING CAPITAL COMPONENTS

Probability of Failure	MDA		Probit	
	F	NF	F	NF
.000 -.1000	3	31	2	10
.1001-.2000	2	1	-	7
.2001-.3000	2	-	1	5
.3001-.4000	1	1	2	4
.4001-.5000	-	-	2	3
.5001-.6000	-	-	2	2
.6001-.7000	1	-	1	1
.7001-.8000	1	-	3	1
.8001-.9000	-	-	1	-
.9001-1.000	23	-	19	-
TOTAL	33	33	33	33

Table 10

PROBABILITY OF FAILURE FOR FAILED AND NONFAILED COMPANIES DETERMINED BY MDA AND PROBIT USING INFORMATION BASED ON MEANS OF VARIABLES WITH ONE AND FIVE WORKING CAPITAL COMPONENTS FOR THREE YEARS BEFORE FAILURE

ONE WORKING CAPITAL COMPONENT

Probability of Failure	MDA		Probit	
	F	NF	F	NF
.000 -.1000	4	24	-	10
.1001-.2000	-	4	1	8
.2001-.3000	2	-	3	1
.3001-.4000	1	-	1	2
.4001-.5000	-	1	1	3
.5001-.6000	2	1	2	4
.6001-.7000	-	1	7	2
.7001-.8000	1	-	5	2
.8001-.9000	1	1	3	-
.9001-1.000	22	1	10	1
TOTAL	33	33	33	33

FIVE WORKING CAPITAL COMPONENTS

Probability of Failure	MDA		Probit	
	F	NF	F	NF
.000 -.1000	1	28	1	15
.1001-.2000	2	2	-	7
.2001-.3000	3	1	1	1
.3001-.4000	-	-	4	1
.4001-.5000	-	1	1	2
.5001-.6000	1	-	-	2
.6001-.7000	-	1	2	1
.7001-.8000	1	-	6	3
.8001-.9000	4	-	6	3
.9001-1.000	21	-	12	-
TOTAL	33	33	33	33

Table 11

LOG OF LIKELIHOOD FUNCTION FROM THE PROBIT ANALYSIS FOR VARIOUS TESTS

ONE YEAR BEFORE FAILURE

Test Number	Test	Log of Likelihood Function
1	Intercept only	-45.748
2	8 funds flow components (NWCFF The only working capital component)	-28.737
3	12 Funds flow components, excluding NWCFF/TNF and substituting AR/TNF, INV/TNF, DCA/TNF, AP/TNF and OCL/TNF	-23.366

THREE YEAR AVERAGE BEFORE FAILURE

4	Intercept only	-45.748
5	8 Funds flow components (NWCFF The only working capital component)	-29.089
6	12 Funds flow components (Excluding NWCFF and substituting AR/TNF, INV/TNF, OCA/TNF, AP/TNF, OCL/TNF)	-24.663